

#### §4. MHD Simulation on Pellet Injection in LHD

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It is well known that an ablation cloud; a high density and low temperature plasmoid, drifts to the lower field side in tokamak plasmas, which leads to a good performance on fueling in tokamak. Such a good performance, however, has not been obtained yet in Large Helical Device (LHD) experiments. In order to clarify that physical mechanism, MHD simulation has been carried out.

Figure 1 shows the behavior of plasmoid 1 located inside the torus on the horizontally elongated cross section. The plasmoid drifts in the negative direction of the major radius, namely to the lower field side. Figure 2 shows the behavior of plasmoid 2 located inside the torus on the vertically elongated cross section. The plasmoid drifts in the negative direction of the major radius, namely to the higher field side. The force acting on the plasmoid in the major radius direction is shown by  $F_R = \mathbf{B}^{eq} \cdot \nabla B_R^{pl} - B_\varphi^{eq} B_\varphi^{pl} / R$ , where  $B^{eq}$  is the equilibrium magnetic field and  $B^{pl}$  is the perturbation of the magnetic field induced by the plasmoid<sup>1)</sup>. The magnetic pressure at plasmoid 1 is a local minimum value along the field line. When the plasmoid is elongated along the field line, the plasmoid flows to the higher field side. Since the flow is disturbed by the higher field, the flow becomes narrowed. The left hand side in Fig. 3 shows that behavior. The magnetic field lines **a** and **b** change to **a'** and **b'**, respectively as the plasmoid flow is narrowed. In result, the magnetic perturbation,  $B_R^{pl}$ , is induced as shown by green arrows. The perturbation of the field **a** is larger than the one of the field **b** due to the difference of the magnetic curvatures between **a** and **b**.  $\mathbf{B}^{eq} \cdot \nabla B_R^{pl}$  of the field **a** and **b** become negative and positive, respectively, and that absolute value of **a** is larger than the one of **b**. Then, the force acting on the whole plasmoid is the negative direction in the major radius, and the plasmoid drifts to the lower field side. The magnetic pressure at plasmoid 2 is a local maximum value along the field line. When the plasmoid is elongated along the field line, the plasmoid flows to the lower field side and that flow becomes broad as shown in Fig. 4.  $\mathbf{B}^{eq} \cdot \nabla B_R^{pl}$  of the field **c** and **d** become negative and positive, respectively, and that absolute value of **c** is larger than the one of **d**. Then, the force acting on the whole plasmoid is the negative direction in the major radius, and the plasmoid drifts to the higher field side. Therefore, both plasmoids 1 and 2 drift in the negative direction of the major radius, and the good performance in fueling is not obtained in the LHD.

1) R. Ishizaki and N. Nakajima, Plasma Phys. Control. Fusion, **53**, 054009 (2011).

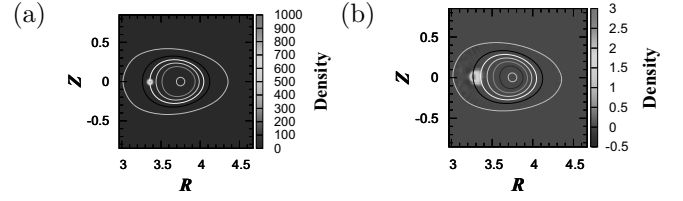


Fig. 1: Density of plasmoid 1 on the horizontally elongated poloidal cross section. Colors and contours show the plasmoid density and equilibrium plasma pressure. (a)  $t = 0$ . (b)  $t = 20$ .

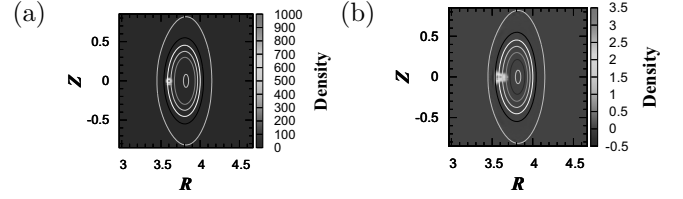


Fig. 2: Density of plasmoid 2 on the vertically elongated poloidal cross section. Colors and contours show the plasmoid density and equilibrium plasma pressure. (a)  $t = 0$ . (b)  $t = 20$ .

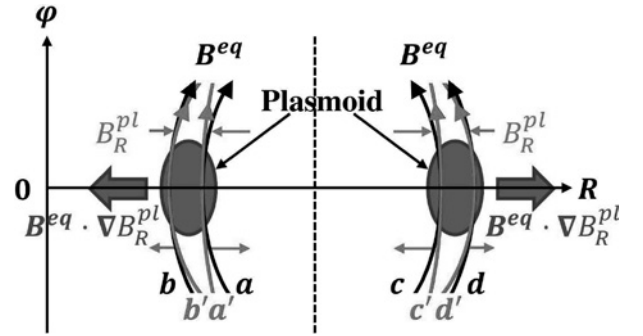


Fig. 3: Plasmoid and magnetic field on  $R$ - $\varphi$  plane when the initial plasmoid is located on the horizontally elongated cross section.

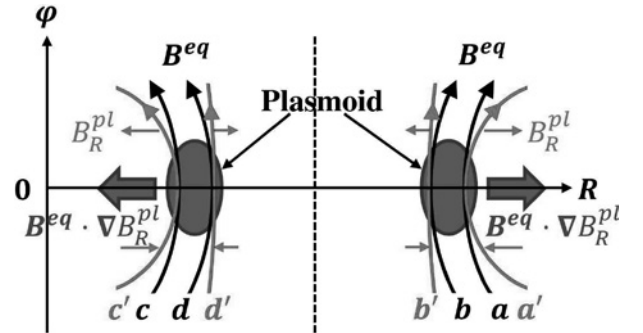


Fig. 4: Plasmoid and magnetic field on  $R$ - $\varphi$  plane when the initial plasmoid is located on the vertically elongated cross section.